

Article XXI.—THE CHAZY OF LAKE CHAMPLAIN.

By EZRA BRAINERD and HENRY M. SEELY.

We present in this article an account of three exposures of the Chazy formation along the shores of Lake Champlain. For the collecting of fossils and for detailed measurements these outcrops are more favorable than at Chazy' village, where the formation was first studied by Professors Emmons and Hall. The rocky shores of islands and promontories in the lake region are cleared of soil by the waves, the lake level is a convenient datum for measurements, and government charts furnish accurate outlines for mapping.

THE VALCOUR ISLAND SECTION.

By far the best exhibit of the Chazy formation is at Valcour Island and on the neighboring mainland, from Bluff Point to Port Jackson. It here attains its maximum thickness. The base of the formation is seen resting upon the yellow magnesian limestone at the top of the Calciferous, and may be traced upward in various exposures through 890 feet of strata, till its summit is seen underlying the Black River limestone.

The strata here measured are as follows, in ascending order :

Group A (Lower Chazy).

- 1. Gray or drab-colored sandstone, interstratified with thin (or sometimes thick) layers of slate, and with occasional thin layers of limestone at the base, containing *Camerella (?) costata* Bill 56 feet.

The slaty sandstone gradually passes into

- 2. Massive beds, made up of thin alternating layers of tough slate and of nodular limestone, containing undetermined species of *Orthis* and *Orthoceras*..... 82 "

¹ See paper, 'The Original Chazy Rocks,' American Geologist, Nov., 1888, Vol. II, p. 323.

3. Dark bluish-gray, somewhat impure limestone, in beds of variable thickness; often packed with *Orthis costalis* Hall, which occurs with more or less frequency through the whole mass. Other fossils are: *Lingula huronensis* Bill., *Harpes antiquatus* Bill., *Harpes ottawaensis* Bill. (?), *Illæus arcturus* Hall (*I. bayfieldii* Bill.), *Lituities*, sp. (?).....110 feet.
4. Gray, tolerably pure limestone in beds 8 to 20 inches thick, separated by earthy seams, the bedding being uneven. Many layers consist of crinoidal fragments, largely of *Paleocystites tenuiradiatus* Hall. Near the middle of the mass, for a thickness of 10 feet, some of the fragments and small ovoid masses (*Bolboporites americanus* Bill.) are of a bright red color.....90 "

Making for the total thickness of *A*338 feet.

Group B (Middle Chazy).

1. Impure, nodular limestone, containing *Maclurea magna* Leseuer....25 feet.
2. Gray, massive, pure limestone, abounding in crinoidal fragments....20 "
3. Bluish-black, thick-bedded limestone usually weathering so as to show pure nodular masses enveloped in a somewhat impure, lighter-colored matrix; everywhere characterized by *Maclurea magna*. Near the middle of this mass, for a thickness of about 30 feet, the fossils are silicified and of jet-black color. The more important, besides *Maclurea*, are species of *Strophomena*, *Orthis* and *Orthoceras*.....210 "
4. Dark, compact, fine-grained limestone, with obscure bedding, weathering to a light gray. Fossils are infrequent, but at a single locality there were collected *Orthis perveta* Con., *Orthis platys* Bill., *Leptæna fasciata* Hall, *Asaphus canalis* Con., *Cheirurus polydorus* Bill., *Harpes*, sp. und., *Illæus incertus* Bill., *Lichas minganensis* Bill., *Sphærexochus parvus* Bill., and several undescribed species..20 "
5. Bluish-black limestone like number 3, but less pure, containing *Maclurea magna* Leseuer, *Orthis perveta* Con., *Strophomena incrassata* Hall, *Orthis disparilis* Con., or *O. porcia* Bill.75 "

Total thickness of *B*.....350 feet.

Group C (Upper Chazy).

1. Dove-colored compact limestone, in massive beds, containing a large species of *Orthoceras*; *Placoparia (Calymene) multicosata* Hall, *Solenopora compacta*; and a large *Bucania*60 feet.
2. Dark impure limestone, in thin beds, abounding in *Rhynchonella plena*; at the base a bed 4 or 5 feet thick is filled with various forms of *Monticulipora* or *Stenopora*125 "
3. Tough, arenaceous magnesian limestone, passing into fine-grained sandstone.....17 "

Total thickness of *C*.....202 feet.

Aggregate thickness of the Chazy on Valcour Island.....890 feet.

Valcour Island, which lies about six miles south of Plattsburgh, N. Y., is over two miles in length and one mile in width. Almost the entire shore is rocky, with deep bays and steep promontories, sometimes fifty feet in height. The strata slope for the most part eastward at an angle of from 3° to 7° ; but a little north of the centre of the island there is a shallow syncline. Along the northwest shore of Sloop Cove is a minor fault, extending across the promontory north of the Cove. The excavation of the bay is doubtless due to this fault. Across the northern end of the island runs a greater fault, with an upthrow on the south side. The strata north of the fault dip to the northeast, the highest rock on the northeast point being the Black River limestone. Underneath, as we go westward, are seen the strata of *Group C*, Chazy, and the upper part of *Group B*.

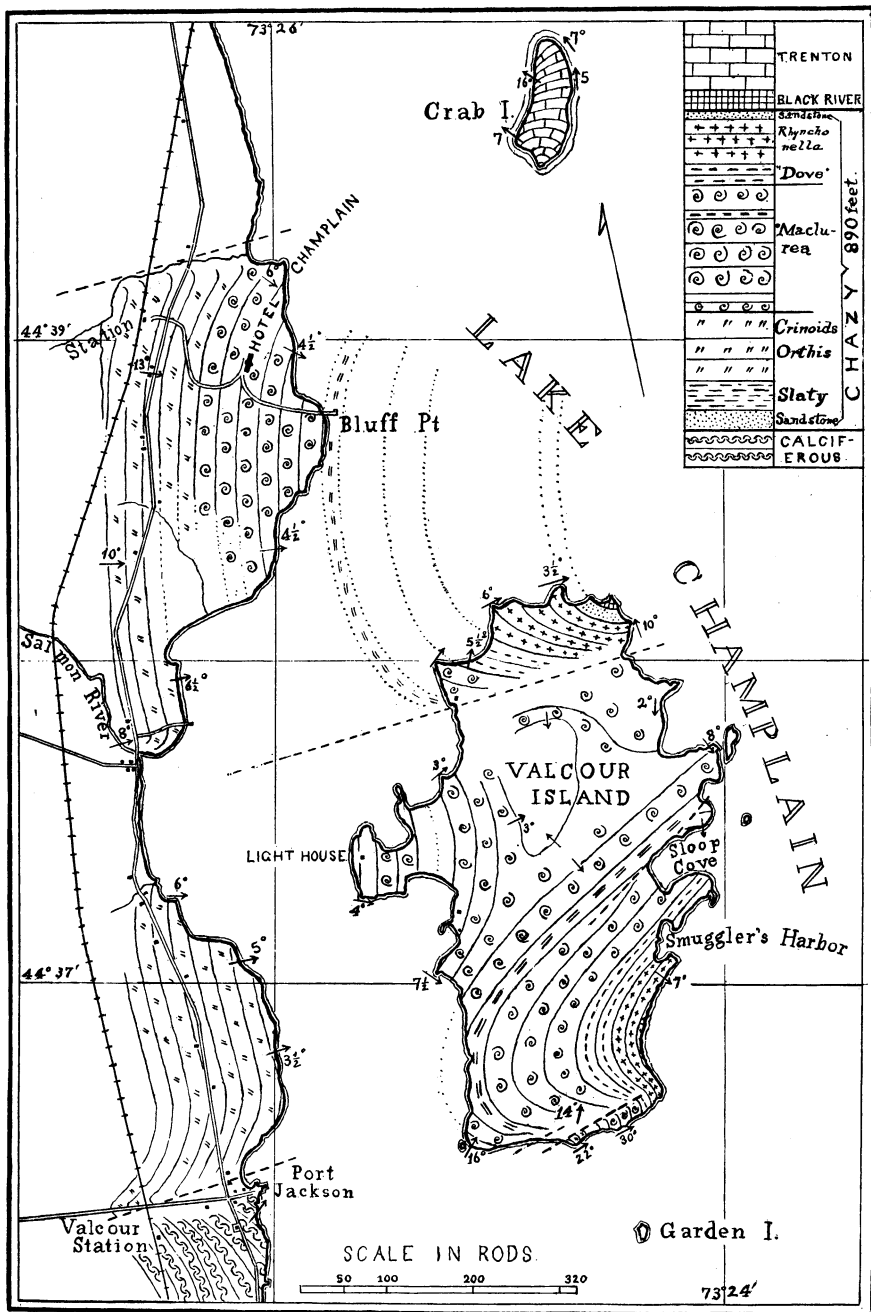
At the south end of the island there is evidence of still greater disturbance. A fault with two branches runs in from the south shore to the northeast, but does not extend to the east shore. The rocks at the southeast are thus tilted to the east at an angle of from 22° to 30° , exposing the sandstone at the very base of the formation. The thickness of Chazy strata seen here is over 600 feet—in fact, the whole of the formation is exposed except the upper 80 feet and about 200 feet covered with soil. This hiatus of the upper part of *Group A* seems to have been caused by the removal by glacial action of the narrow mass of rock between the fault and the shore line. About one hundred rods southeast is a small rocky island, called Garden Island, consisting of the slaty strata of *Group A*, and lying in the strike of the same strata on Valcour Island.

If we turn our attention now to the mainland, we shall find the Chazy rock extending for three miles along the shore to the west of Valcour Island. It is terminated on the north by a transverse fault with an uplift on the south, as is indicated by a sudden westward curvature of the strike of the Chazy. North of this fault is a sand plain extending to the village of Plattsburgh. On the south also the Chazy uplift is terminated by a fault (another branch of the fault seen on the south side of Valcour Island), bringing up here the strata of the Calciferous. It is a noteworthy fact that all these principal faults, like those observed at Ticon-

deroga and elsewhere along the lake, consist of uplifts of the strata nearest to the neighboring Archean terrane. It is only four miles from Port Jackson south to the well-known display of Potsdam sandstone at the Ausable Chasm, and only six miles south to the Archean of Trembleau Point.

The strike of this outcrop of Chazy is quite uniformly north and south, with an eastern dip increasing as we go westward from 3° to 12° . It consists of the lower strata of the Chazy, though the sandstone at the base of the formation is not disclosed. The lowest rock seen is the slaty limestone (A, 2), well exposed in the bed of the Salmon River near its mouth. The remaining strata of *Group A* are displayed in long ledges lying on either side of the highway between Port Jackson and Plattsburgh. Especially favorable for the collecting of fossils are the old quarries and the broad fringe of sloping rocks along the shore for a mile north of Port Jackson. About fifty rods south of the Bluff Point Railway station are extensive quarries in the crinoidal beds of No. 5, A, from which a beautiful red-spotted marble is manufactured. As we go eastward from the station to the Hotel Champlain we pass rapidly over the lower Maclurea beds, till we reach the summit of the ridge on which the hotel is situated, 180 feet above the lake. The eastward slope, south of the driveway to the wharf, is with the strata, which here consist of the massive beds of No. 4, B, broken at the shore-line so as to form high cliffs. It is highly probable that the higher strata continue eastward under the waters of the lake, and are connected without a break with the exposures of the Upper Chazy at the north end of Valcour Island. We may also infer that the outcrop north of Port Jackson is continuous under the lake with the outcrop on the Light House promontory and the main body of Valcour Island. For the dip and strike on both sides of the channel are similar, and the strata here lacking have a thickness elsewhere which would nearly fill the gap between the island and the mainland.

Before closing our account of this interesting region, we would call attention to the fine outcrop of Trenton limestone at Crab Island, about a mile northeast of Bluff Point. The island is only 145 rods in length, but discloses over 200 feet of strata. As will



VALCOUR IS. AND BLUFF PT., N. Y.

be seen from the strike and dip indicated on the map, it is the remnant of a sharp anticline with an axis descending north-northeast. Strata in this attitude would offer the greatest possible resistance to glacial action, and this may account for the existence of the island.

ISLE LA MOTTE SECTION.

Our second map represents the outcrop of Chazy limestone at Isle La Motte, which lies about 14 miles to the north of Valcour Island. The strata appear on the south half of the island with a somewhat sinuous strike and dipping northward at an angle of from 3° to 5° . After 60 feet of Calciferous rock we have the following measures of the Chazy in ascending order :

Group A (Lower Chazy).

- | | |
|---|----------|
| 1. Layers of sandstone and slate containing <i>Lingula</i> and <i>Orthis</i> | 23 feet. |
| 2. Silicious limestone with seams of tough slate containing <i>Camerella breviplicata</i> Bill., <i>Orthis porcia</i> Bill., <i>Strophomena aurora</i> Bill., <i>Strophomena camerata</i> Con., <i>Zygospira acutirostra</i> Hall, <i>Asaphus canalis</i> Con., <i>Cheirurus vulcanus</i> Bill., <i>Illænus crassicauda</i> Wahl. (?), <i>Remipleurides schlotheimi</i> Bill..... | 55 " |
| 3. Massive beds crowded with <i>Orthis costalis</i> Hall..... | 75 " |
| 4. Crinoidal beds containing univalves and the layer of red-spotted marble ; <i>Columnaria parva</i> Bill. occurs near the top..... | 70 " |
| Total exposure of <i>A</i> | |
| 223 feet. | |

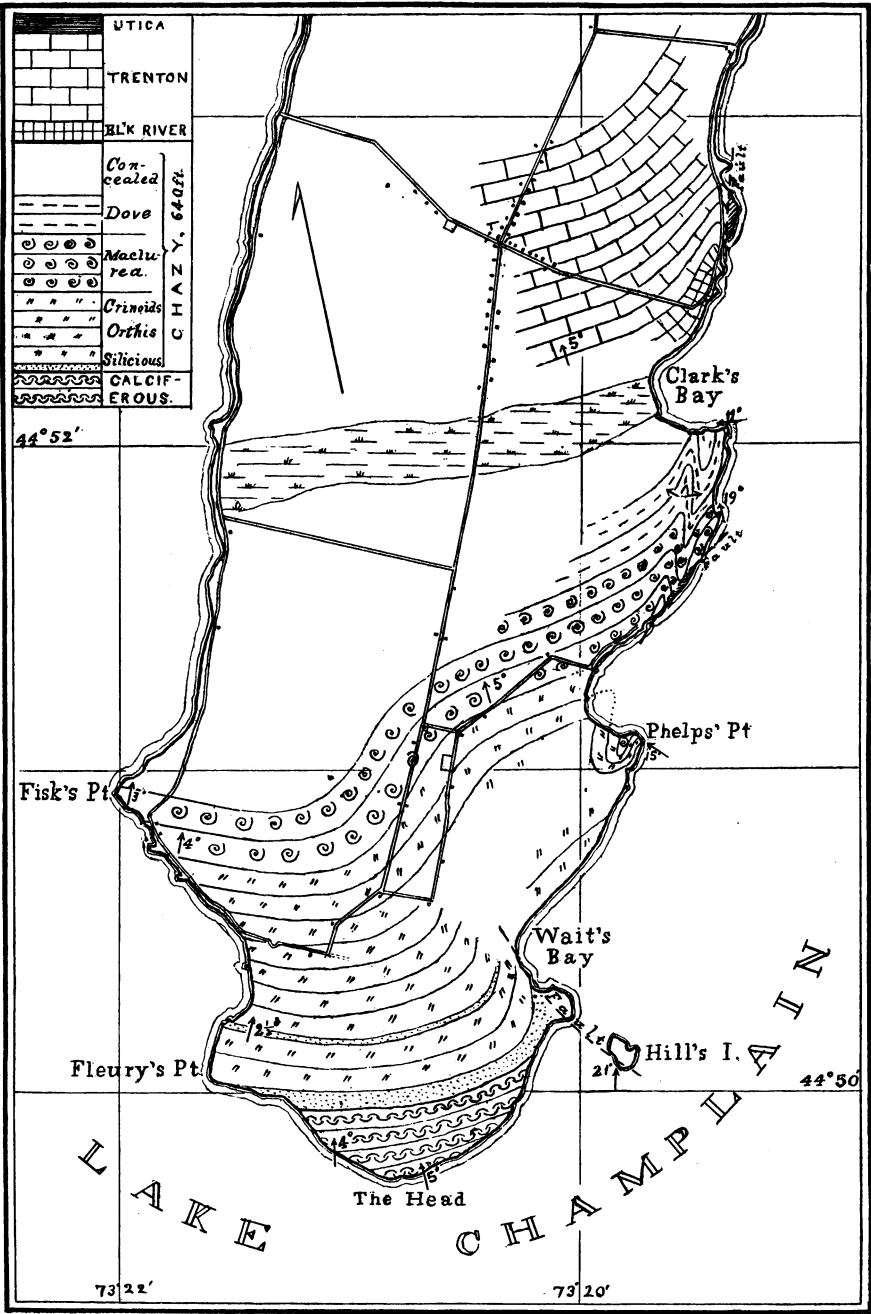
Group B (Middle Chazy).

Bluish-black, massive limestone like *B*, 3, at Valcour Island, containing *Maclurea magna* in abundance, and strata largely filled with *Stromatocerium*. The gray oolitic bed is found here at the base of the group, and the strata at the top are unusually massive, about 150 feet.

Group C (Upper Chazy).

- | | |
|---|-----------|
| 1. Pure, fine-grained, dove-colored limestone with intercalated beds of silicious and dolomitic, iron-gray limestone, containing <i>Cyrtoceras boycii</i> Whitf., <i>Orthoceras titan</i> Hall, <i>Placoparia multicosata</i> Hall, <i>Lichas champlainensis</i> Whitf., and undescribed species of <i>Illænus</i> and <i>Bucania</i> | 120 feet. |
| 2. Concealed..... | 150 " |

Total thickness of Chazy at Isle La Motte.....643 feet.



ISLE LA MOTTE, VT

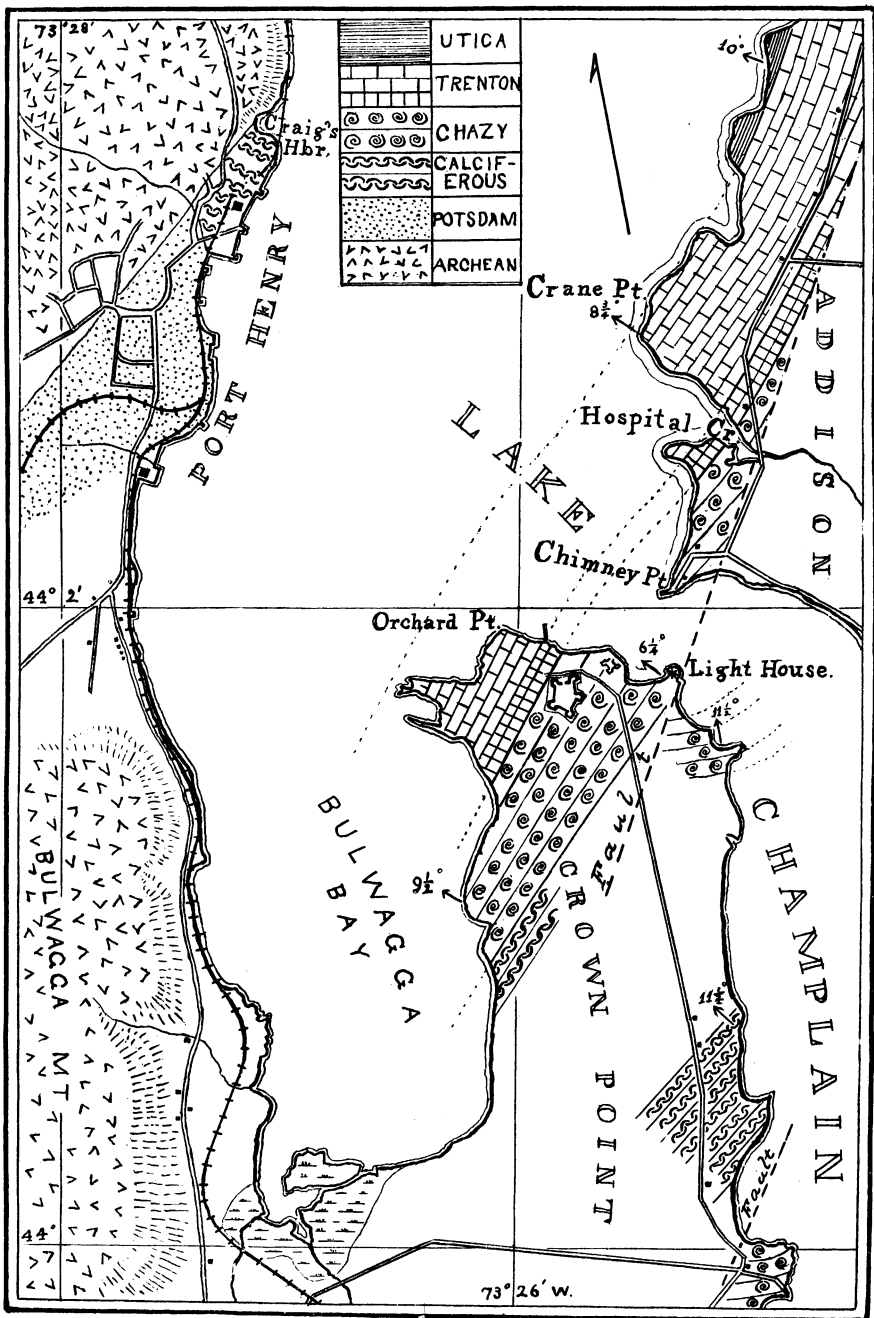
The south end of the island affords excellent opportunities for the study of the Lower Chazy. The rocks are well exposed along the shore, in the interior pastures of the headland (which rises about 100 feet above the lake), and in numerous quarries which have been extensively worked for over seventy-five years. In using the map for field work it should be remembered that the shading indicates the position of the strata on a horizontal plane at the level of the lake. Because of the small dip the exposures of these various strata at *elevated* points should be looked for farther south than indicated on the map.

The east shore of the island shows signs of great disturbance. A fault may be seen running from the head of Wait's Bay across the promontory on the south and farther southeastward across Hill's Island. Half a mile south of Clark's Bay the Utica slate is brought into contact with the Maclurea beds, which are here seen to have been abruptly folded, as is indicated on the map by the zigzag strike and the greatly increased dip. Two hundred rods to the north of Clark's Bay the Utica slate is again seen, but in contact with the Trenton limestone.

To the west of Clark's Bay the rocks have been eroded below the surface of the lake, and a wide marsh extends across the island. To the north of the marsh are seen beds of the Trenton, which may be traced to the east shore, where they are found to overlie the Black River limestone. Away from the shore the strike and the dip of the Trenton are uniform and identical with the strike and the dip of the Chazy to the south of the marsh; we may, therefore, suppose that the concealed strata are the uppermost beds of the Chazy, which at Chazy village, six miles to the west, and at Valcour and at Grand Isle, consist largely of *Rhynchonella plena*. In fact, boulders of these strata are found on the shore of Isle La Motte to the south of the marsh.

THE CROWN POINT SECTION.

Our third map represents the geological outcrop at Crown Point, N. Y., about forty miles south of Valcour Island. The region is one of unusual interest, as we here find representatives of all the formations that appear in the Champlain Valley from



CROWN PT., N.Y., AND VICINITY.

the Archean to the Utica slate. The measures of the Chazy here disclosed are as follows, in ascending order :

A	{	1. Sandstone and slate interstratified.....	23 feet.
		2. Impure limestone containing <i>Orthis platys</i> Bill.....	25 "
B		Beds containing <i>Maclurea magna</i>	200 "
C	{	1. Dark gray, massive limestone, weathering in darker stripes an inch wide, containing <i>Bucania</i> , sp. und.....	40 "
		2. Tough, silicious and magnesian rock, passing into a two-foot bed of pure sandstone.....	17 "
Aggregate thickness.....			305 feet.

North of Port Henry the Archean gneiss forms high bluffs on the west shore of the lake, and is well exposed for study by the extensive cuttings made in the construction of the D. & H. Railroad. West of the old furnace a large excavation has been made in the Archean limestone, which has been here quarried for flux. The village of Port Henry is underlain by the Potsdam sandstone, resting upon which may be seen the dark magnesian limestone at the base of the Calciferous. The railroad tunnel just west of the Bay State furnace passes through these strata, showing a northeastwardly dip of about 8° . North of the tunnel and extending to Craig Harbor is the pure limestone of *Group B* of the Calciferous, which is here, as well as elsewhere along the lake, a favorite source of flux for the iron-makers.

The higher measures of the Calciferous are to be found on the east side of the Crown Point peninsula. The rocks are largely covered with the Champlain clay, but the fossils would seem to indicate that we have here the strata of *Group D*. On the east shore of Bulwagga Bay we find the uppermost beds of the Calciferous underlying the measures of the Chazy as above described. From Bulwagga Bay the Chazy runs northeastwardly to the end of the promontory, and underlies the extensive ruins of the English fort and of the old French fort—Fort Frederick. Across the lake, which is here contracted to a width of twenty-five or thirty rods, the Chazy re-appears on Chimney Point, with a dip and strike indicating that the beds are continuous with the outcrop on Crown Point. They are terminated on the east by an oblique fault, with a downthrow on the east. The fault is well exposed on the lake shore just east of the Lighthouse; and a few rods farther south we find the upper Chazy with a dip of

11½° to the north. A similar fault occurs two miles farther south, where the Chazy appears in a downthrow, to the east of the Calciferous.

In the old fosse north of the English fort, near its entrance, may be seen the pure, dove-colored, brittle limestone at the base of the Black River, overlying the stratum of sandstone, which here as well as at Valcour caps the Chazy. The darker limestones of the Black River appear on the shore north of the fort, and were quarried in past years for black marble. Overlying them to the west are the ordinary strata of the Trenton. The Black River limestone may also be seen near the mouth of Hospital Creek, on the Vermont side of the lake, and extends northerly for nearly a mile, until apparently cut off by the oblique fault before mentioned.

To the west of this outcrop of the Black River there is a fine display of the whole of the Trenton limestone—on Crane's Point and at Norton's Bay. Its thickness is found to be 314 feet. To the north for several miles along the shore are exposures of the Utica slate.

In closing, we would call attention to the outcrops of the Chazy formation at Ball's Bay and at Providence Island, as represented in maps to illustrate the Calciferous, heretofore published in the 'Bulletin' of the American Museum of Natural History (Vol. III, pp. 15 and 18).

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ERRATA.

- Page 54, line 6, for 'Dycotyles' read 'Dicotyles.'
- " 75, line 18, for 'Great Dame' read 'Great Dane.'
- " 242, last line, for 'Microtus pallidus' read 'Microtus pauperrimus.'
- " 288, last line, for *αγριος* read *ἄγριος*.

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